Observation of W decay in 500GeV *p+p* collisions at RHIC

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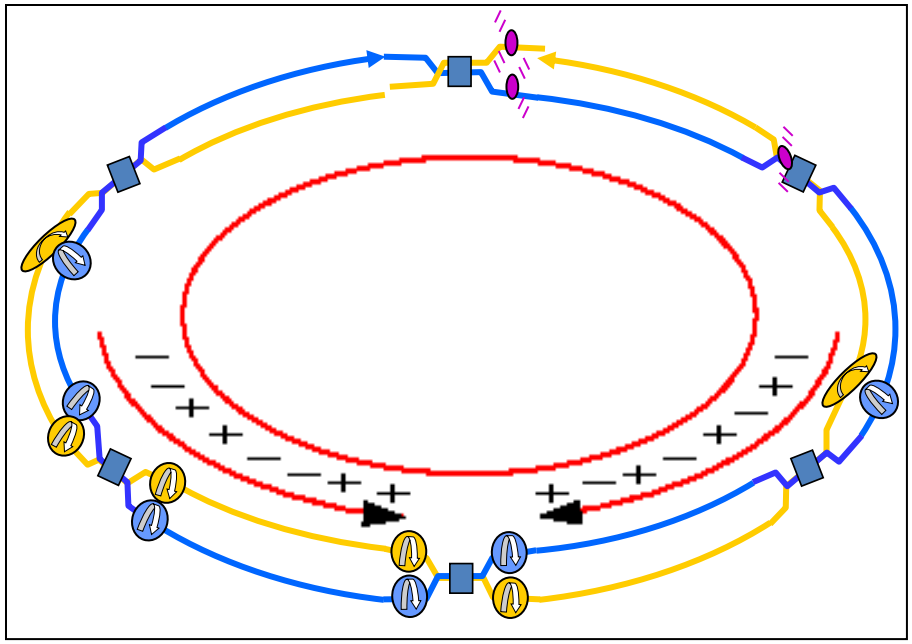
W at RHIC



- An unique probe to access the flavor dependence of polarized sea quarks.
- Parity violating single spin asymmetry (A_L).

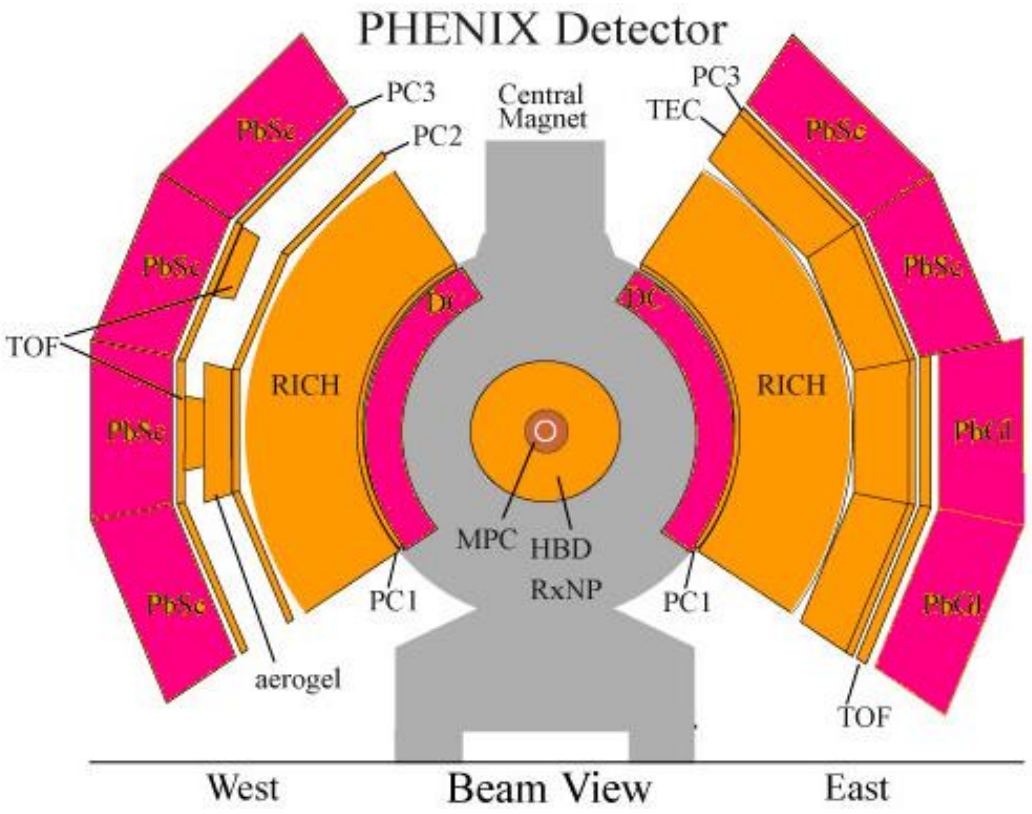
RHIC-PHENIX 2009 run

- First 500GeV *p+p* run. (March to April, 2009)
- Polarization is <P>=0.39±0.04
- Integrated luminosity (with vertex cut) is ∫Ldt=~~9.3~~8.6/pb

Confirmation of electron decay of W (central)

Commissioning of new detectors for muon decay of W (forward)

PHENIX Central arm



For $W \rightarrow e^{\pm}$ channel

EMCal + DC/PC1 tracking

Acceptance :

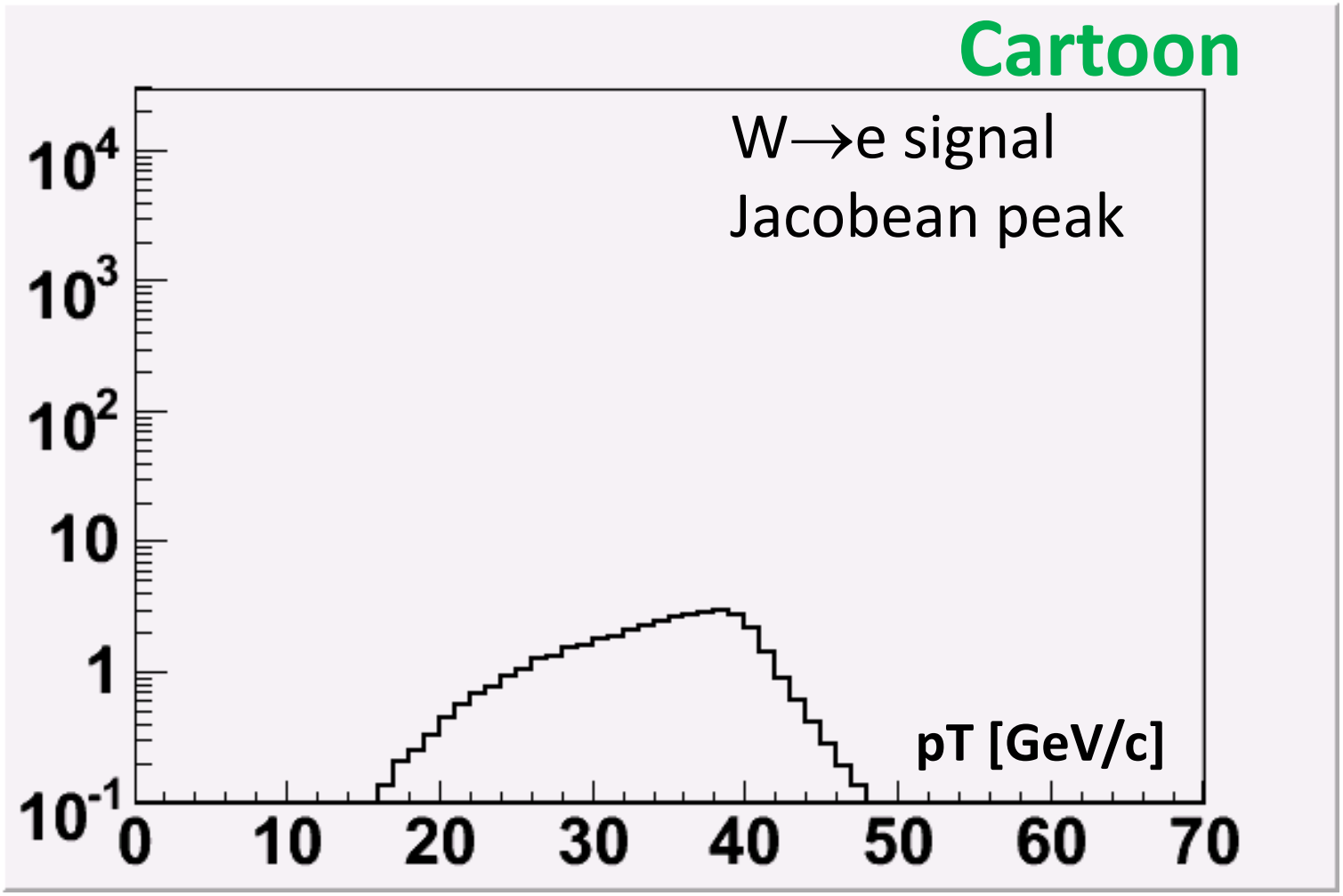
± 0.35 in rapidity

0.5π*2arms in ϕ

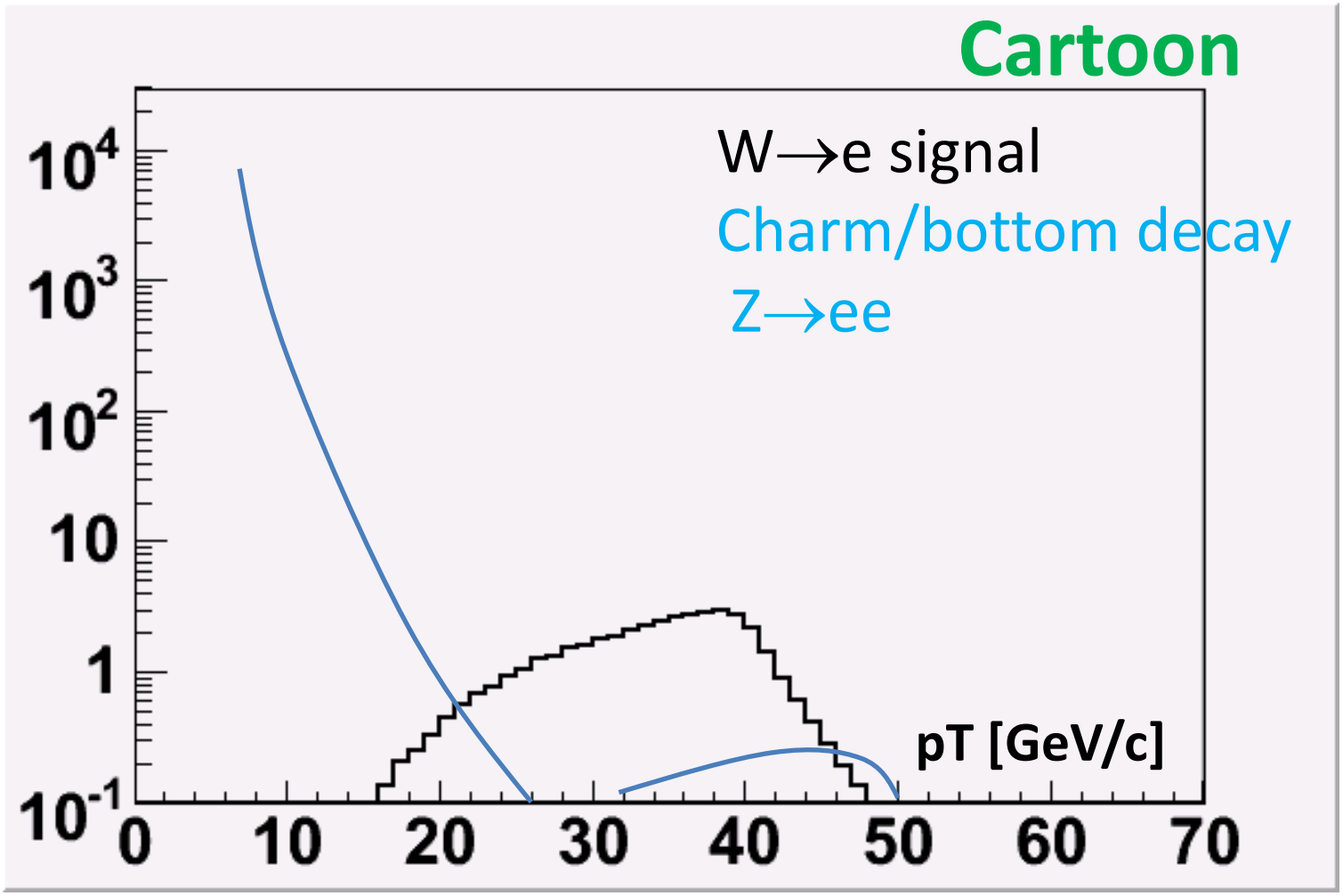
EMCal Trigger

Fully efficient at 12GeV

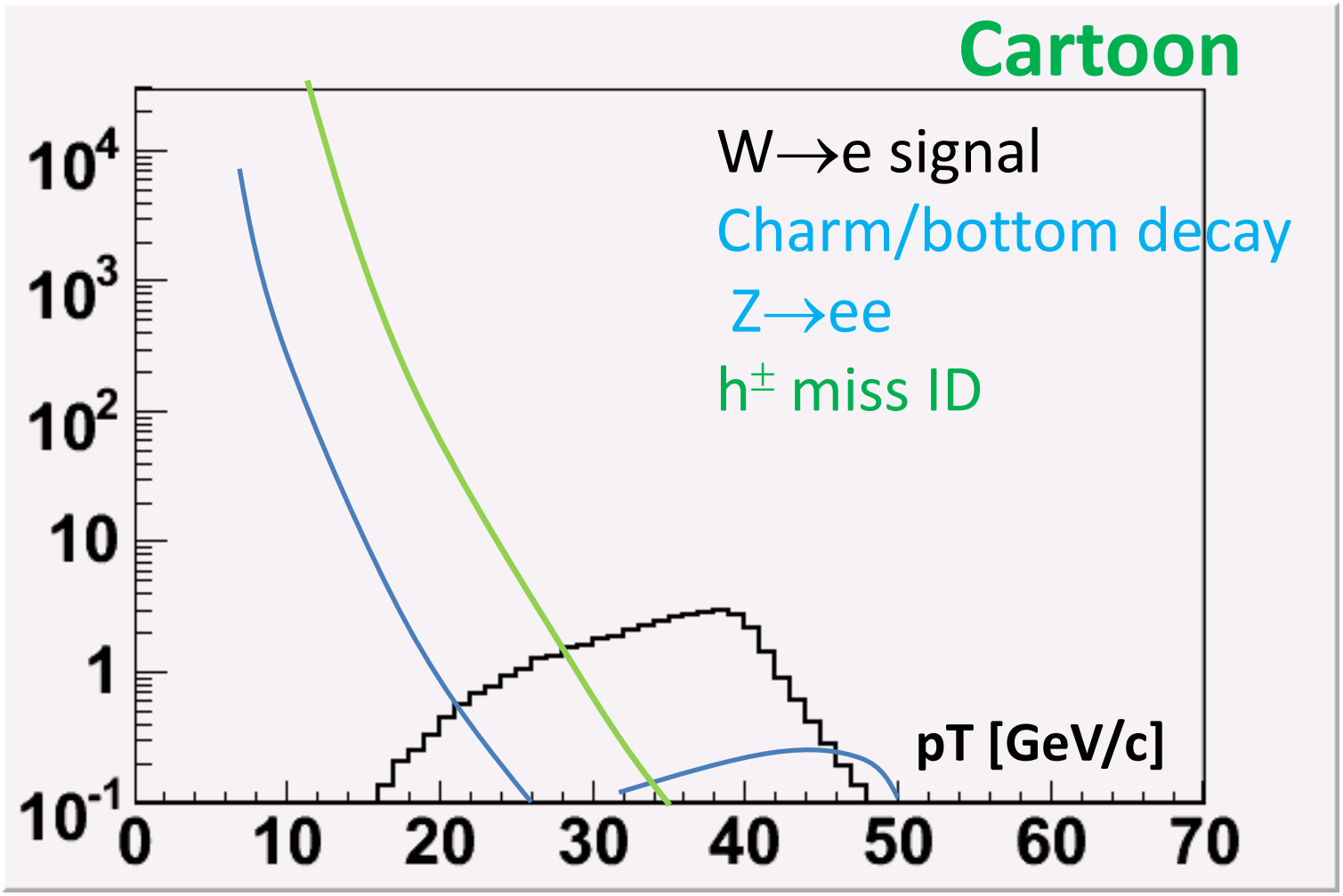
Expected W decay signal



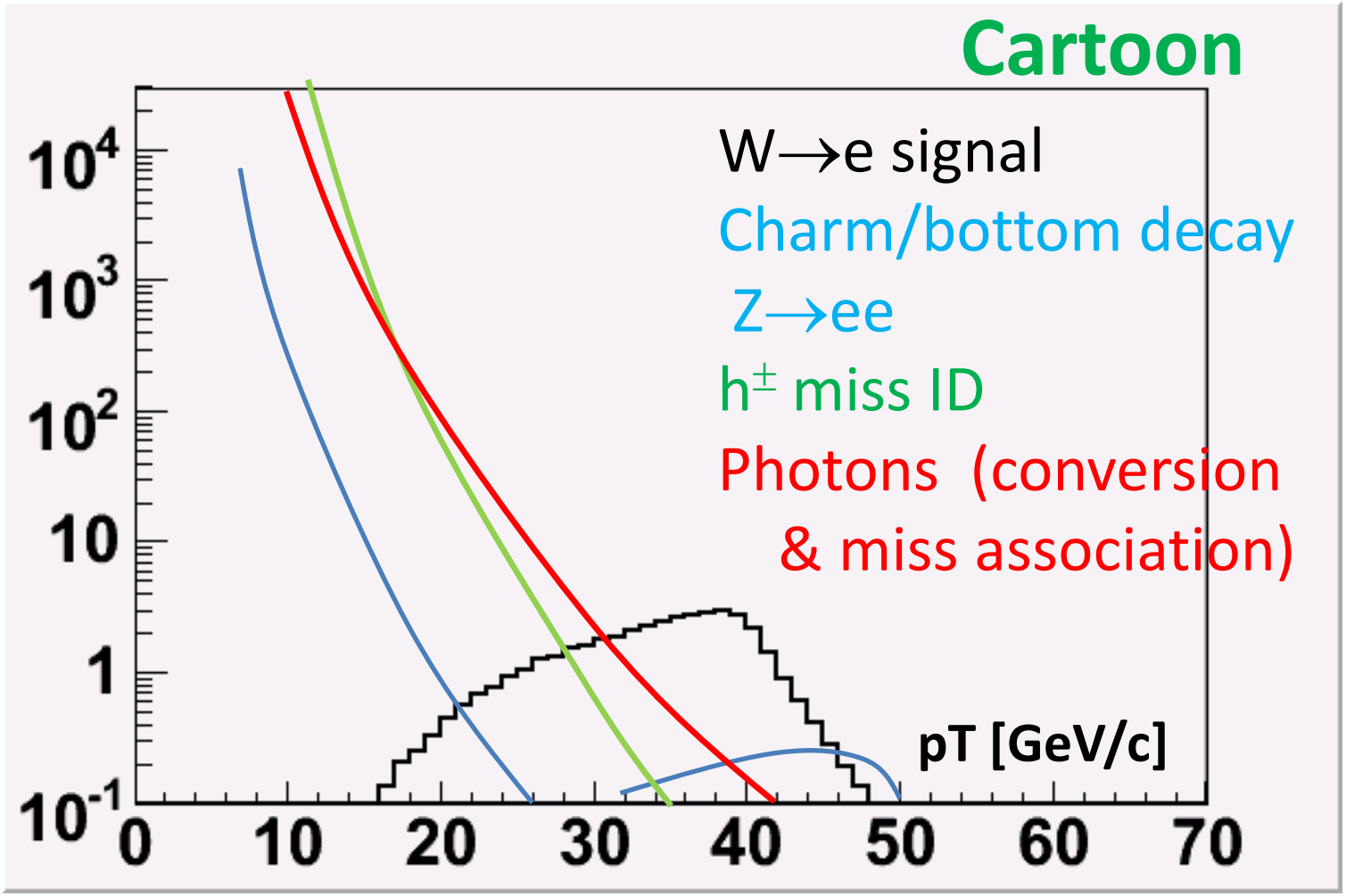
Expected W decay signal



Expected W decay signal



Expected W decay signal

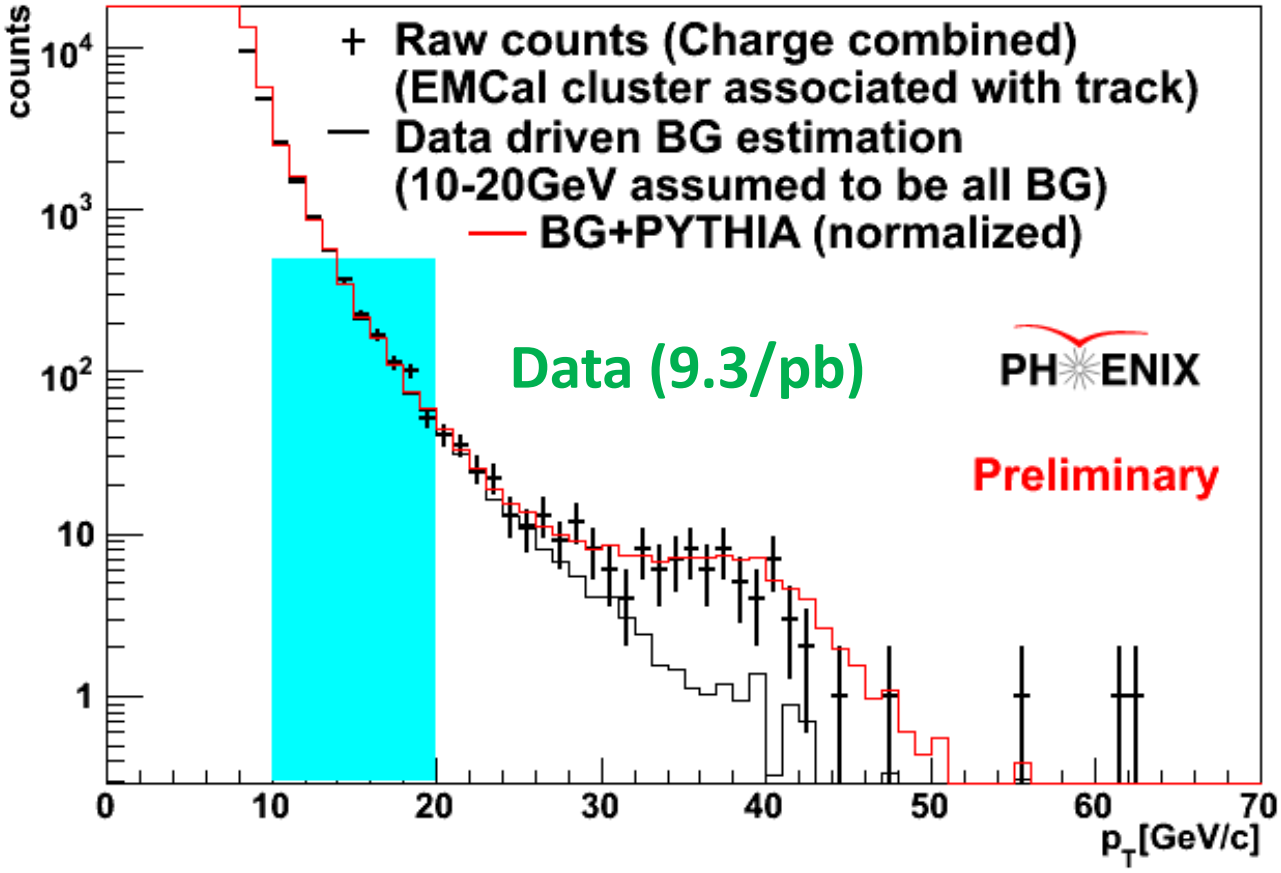


Measured spectra

Data driven BG estimation:

EMCal cluster x (conversion & mis association probability)

The rest is explained by the $h^{\pm}$ shape (NLO pQCD+EMCal response)



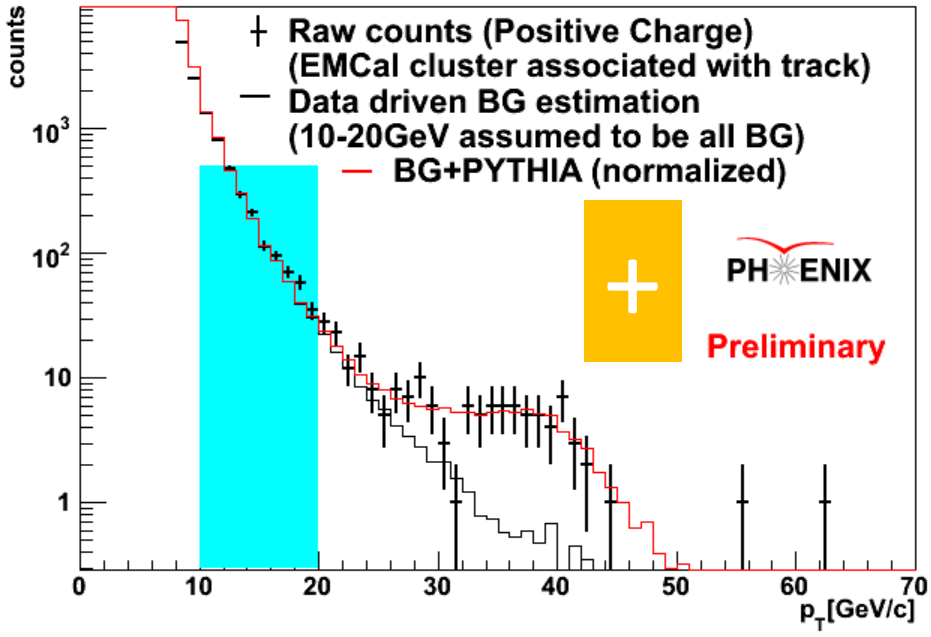
The bump is W+Z signal.

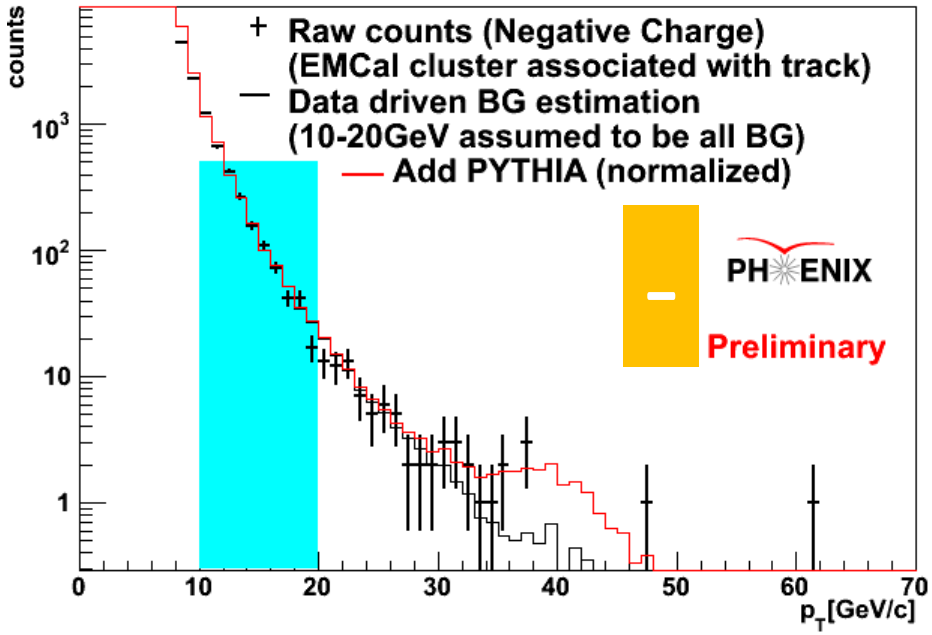
(shape & yield)

Charge separated spectra

Charge sign :

from DC angle (2.3σ separation for 40GeV/c track)





The same factor was used for signal shape.

$W^- \rightarrow e^-$ signal has less acceptance than $W^+ \rightarrow e^+$ signal.

Parity violating single spin asymmetry

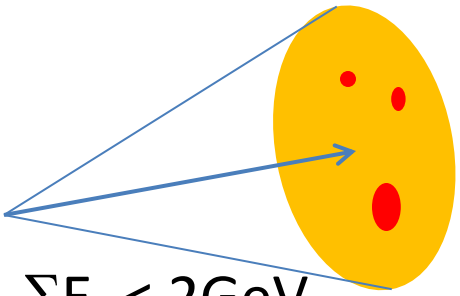
- RHIC has 120 bunch cycle (each bunch 106ns). It reduces systematic uncertainties of detector time dependence.
- The sample are sorted by the spin state and calculate the asymmetry.

$$A_L^W = \frac{1}{P} \times \underbrace{\frac{N^+(W) - N^-(W)}{N^+(W) + N^-(W)}}_{\text{Raw asymmetry}}$$

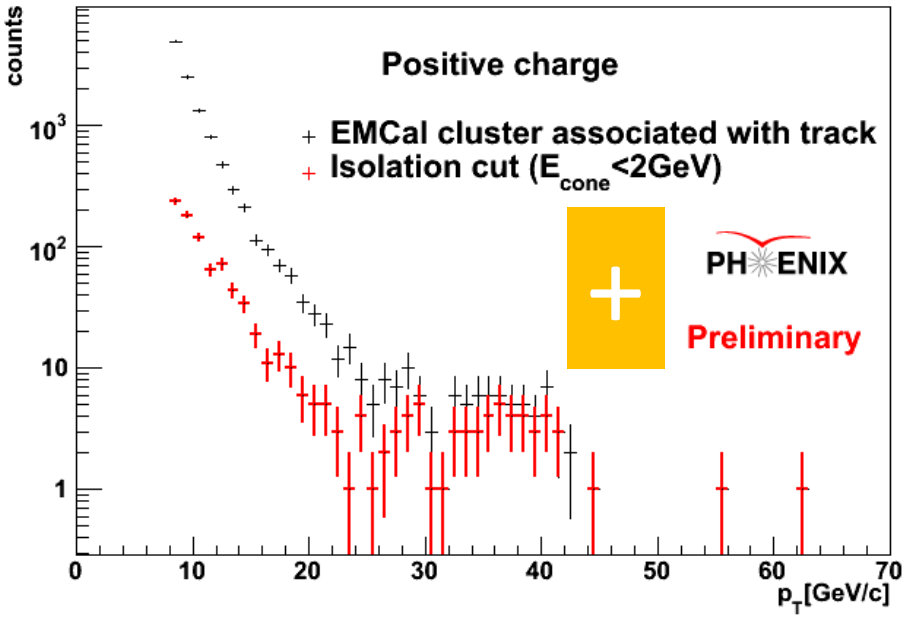
N^+ : helicity +
N^- : helicity –
normalized by $\int L$

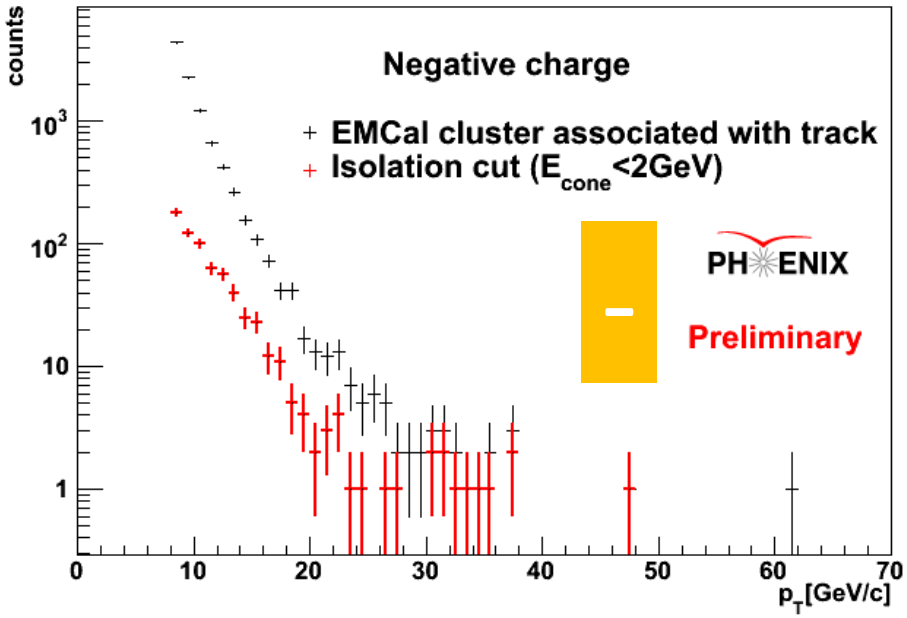
Isolation cut

We can apply any cut
to improve S/N ratio,
if it's spin independent



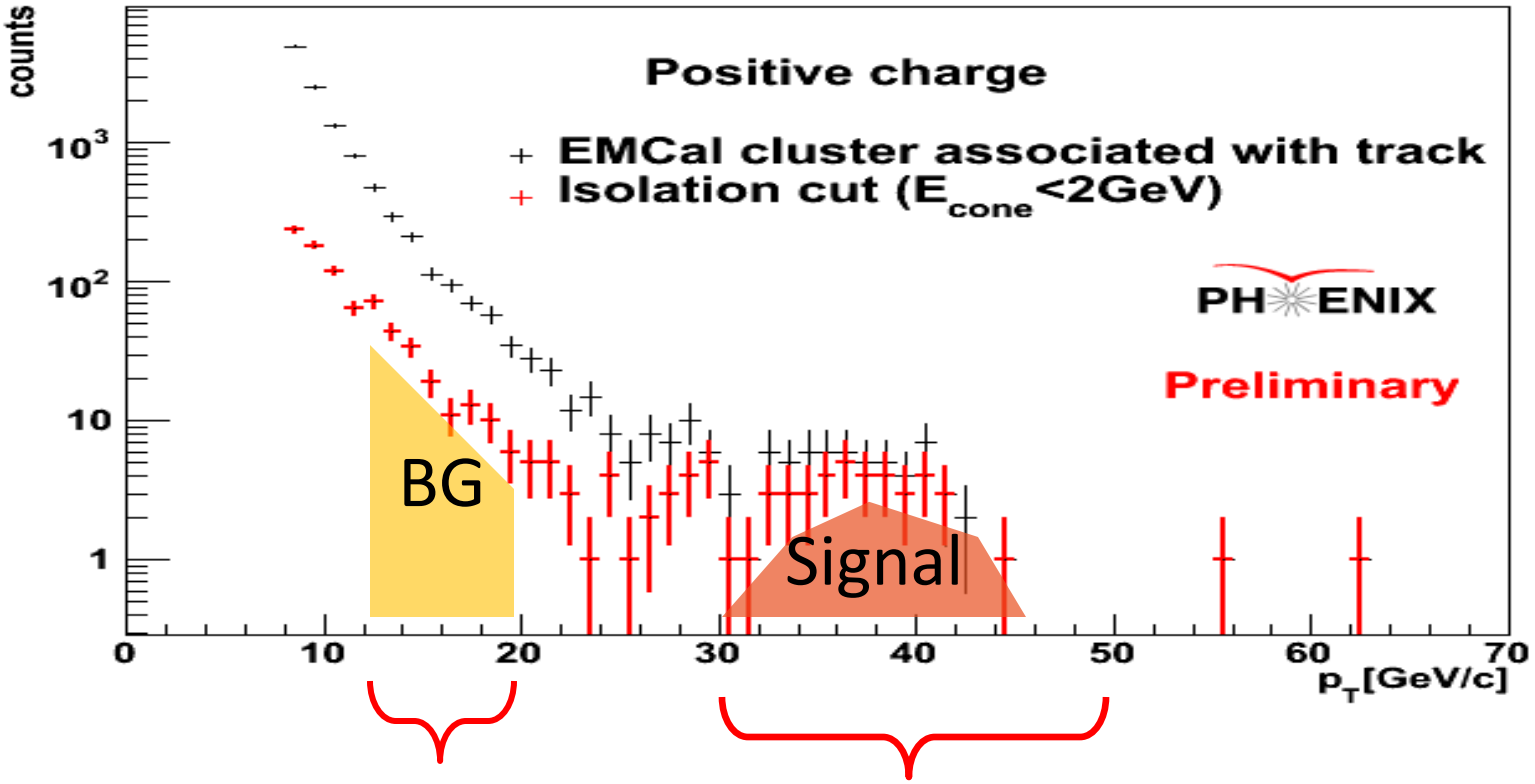
$\Sigma E < 2GeV$





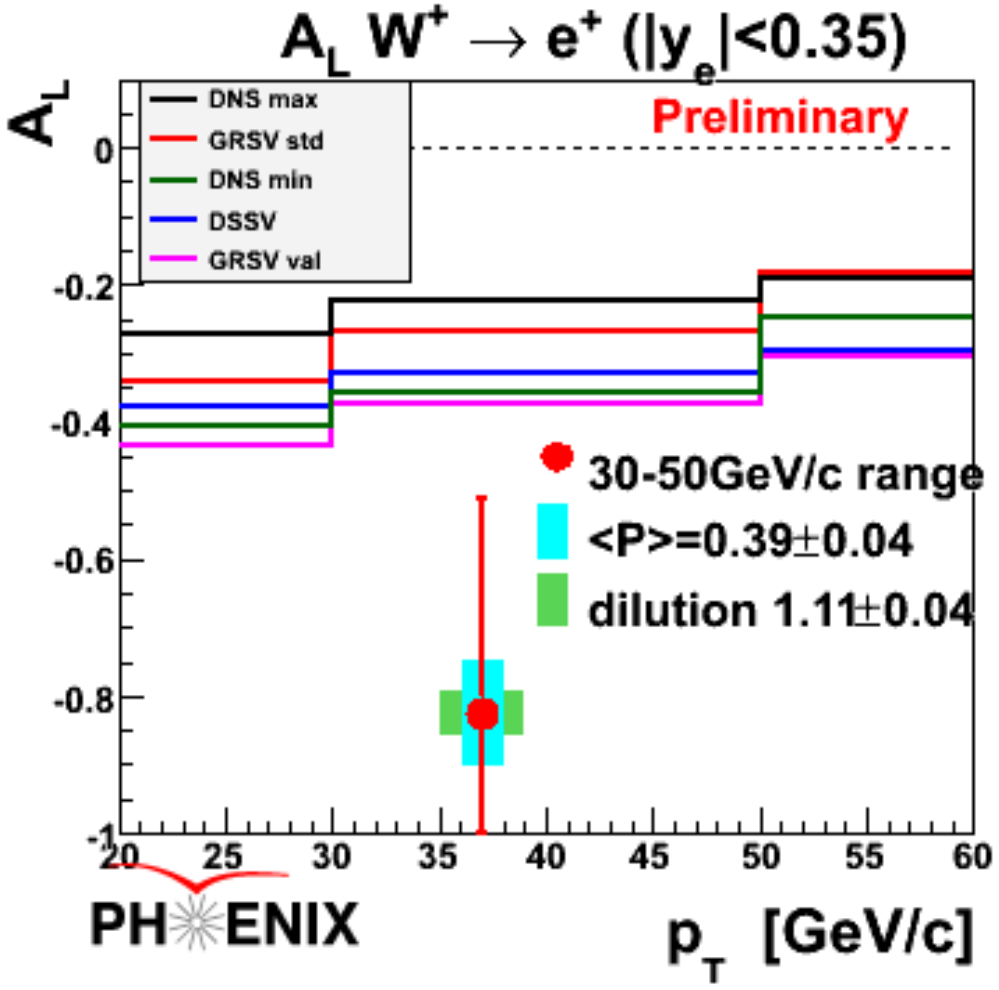
90+% of signal is kept (red histograms)

Raw asymmetries (positive particle)



	pT range [GeV/c]	raw asymmetry
Background	12-20	0.035±0.047
Signal	30-50	-0.29±0.11

Physics asymmetry



Raw asymmetry
→ Physics asymmetry (A_L)

x 1/<P> beam polarization
x Dilution factor
(BG from Z, hadron)

Summary

- PHENIX observed $W \rightarrow e$ decay at mid rapidity region.
- First attempt to measure single spin asymmetry has detected a parity violating asymmetry leading to a preliminary value of A_L

- $A_L^{W+ \rightarrow e+}$ is measured.

  $-0.83 \pm 0.31 \pm$ (scale uncertainty)

  It is consistent with the predictions.

Outlook

- 2009 run was a short test.
- We plan to accumulate more 500GeV *p+p* data in the next few years.
- RHIC expects higher polarization.
- The PHENIX detector is undergoing considerable upgrades to enable a program of measurements of $W^{\pm}$ in the forward direction